IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

N07/4/BIOLO/HP3/ENG/TZ0/XX+

88076003

BIOLOGY
HIGHER LEVEL
PAPER 3

Monday 5 November 2007 (morning)

1 hour 15 minutes

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

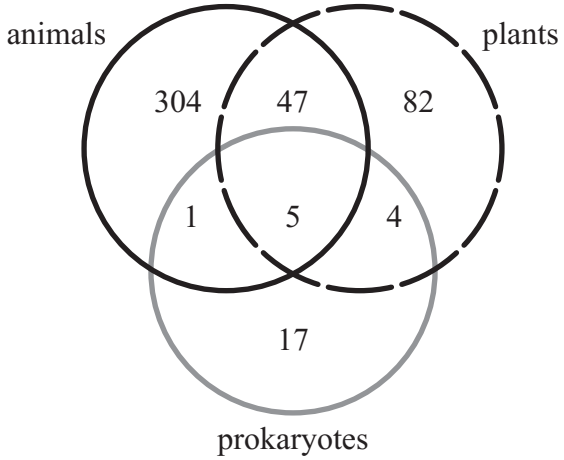
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.

Option D — Evolution

D1. Proteins such as keratin and myosin consist of two or more alpha helices winding around each other into a super-coil and are known as long coiled-coil (LCC) proteins. Such proteins are involved in a wide variety of structural and mechanical processes in cells.

A study was carried out to compare the presence of LCC proteins in species from different kingdoms. The LCC proteins were grouped by similarities in primary structure. They were then analysed to show family relationships and homology.

The diagram below shows the distribution of groups of LCC protein sequences by kingdom.



[Source adapted from: A Rose, S Schraegle, E Stahlberg and I Meier, *BMC Evolutionary Biology*, (2005), **5**, page 66]

(a) State how many groups of LCC proteins are common to all the species studied. *[1]*

. . . . . .

(b) Calculate how many groups of LCC proteins are found in the prokaryote kingdom. *[1]*

Number of groups: . . . . . .

(This question continues on the following page)

(Question D1 continued)

(c) Calculate the percentage of groups analysed that are found in the animal kingdom only. *[1]*

Percentage of groups: . . . . . .

(d) Deduce whether this data supports the hypothesis that plants are more closely related to animals than to prokaryotes. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(e) Explain how data on protein sequences from several species could be used to indicate phylogeny. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

D2. (a) State **two** conditions under which the Hardy-Weinberg principle applies. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) State the full classification of humans. *[2]*

	Kingdom		Animalia
	Phylum	I	. . . . .
	Class		Mammalia
II	. . . . .	III	. . . . .
	Family	IV	. . . . .
	Genus		*Homo*
	Species		*sapiens*
	Sub-species		*sapiens*

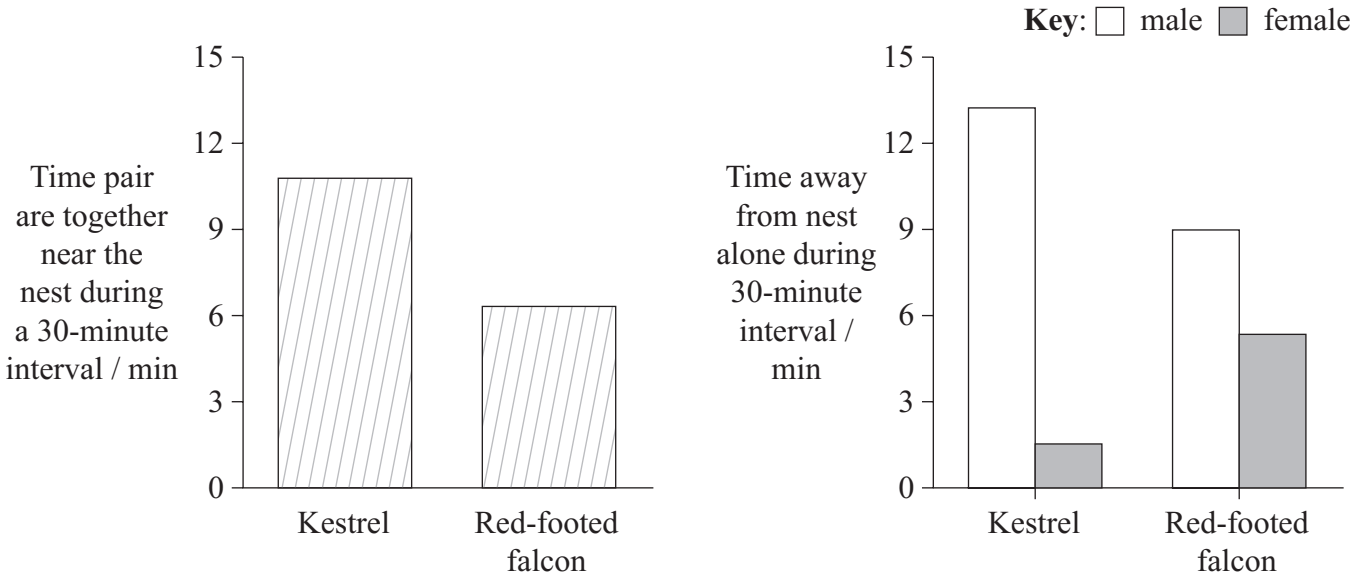
D3. (a) Explain the process of speciation. *[5]*

(b) Describe the evidence for evolution provided by the vertebrate pentadactyl limb. *[4]*

Option E — Neurobiology and Behaviour

E1. Male birds often have behavioural strategies to ensure that they are the fathers of the offspring produced by their mates. One strategy used is "mate-guarding" of the female by the male. However, this may be difficult in birds of prey if they leave the nest to hunt over large areas.

A study was carried out in Austria to see if there was any difference in mate-guarding between two species of falcons. The kestrel, *Falco tinnunculus*, is usually a solitary breeding bird whereas the red-footed falcon, *Falco vespertinus*, is a bird that breeds in colonies. Observations of thirty-eight pairs of falcons were made during the breeding season. The amount of time pairs spent together near the nest or away from the nest was recorded throughout the day during 30-minute intervals. Mean values are shown in the graphs below.



[Source adapted from: R Ille, H Hoi, F Grinschgl, R Zink, *Etologia*, (2002), **10**, pages 11–15]

(a) Compare the time spent away from the nest alone for the two species. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(This question continues on the following page)

(Question E1 continued)

(b) Calculate how much more time the kestrels spent together near the nest than the red-footed falcons per hour. *[2]*

. . . . . .

. . . . . .

. . . . . .

(c) Discuss if the data support the researchers' view that the red-footed falcon shows less mate-guarding than the kestrel. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

E2. (a) State **one** function of each part of the brain listed below.

(i) Hypothalamus: . . . . . *[1]*

(ii) Medulla oblongata: . . . . . *[1]*

(b) Outline Pavlov's experiments on conditioning in dogs. *[3]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

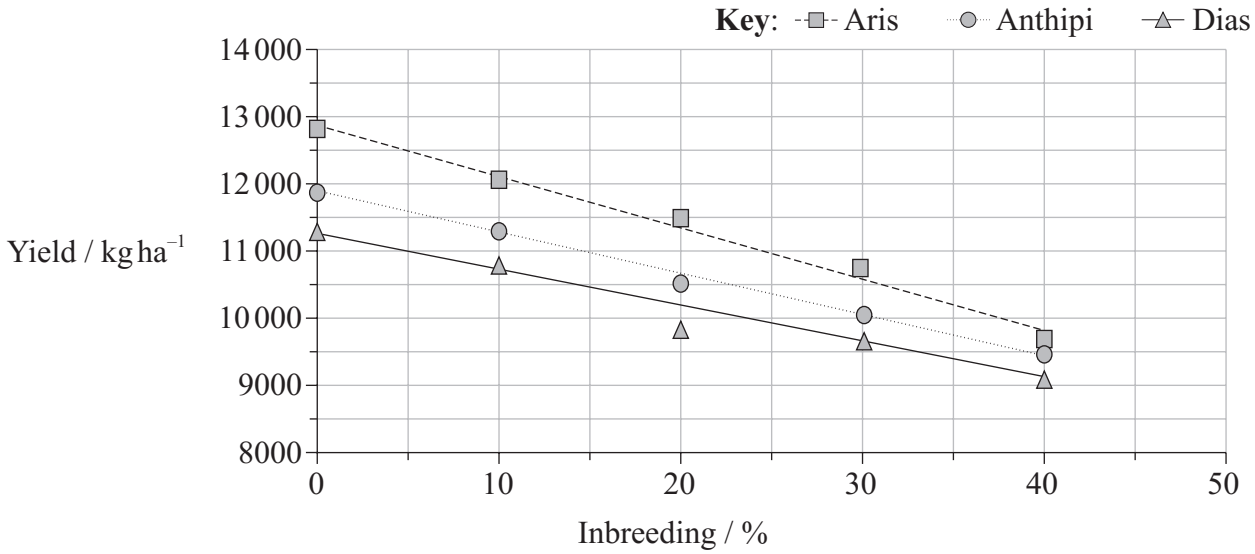
E3. (a) Discuss how **either** bladder **or** anal control is brought about. *[4]*

(b) Explain how presynaptic neurons can affect postsynaptic transmission of nerve impulses. *[5]*

Option F — Applied Plant and Animal Science

F1. A study was carried out in Larissa, Greece, to explore the impact of using low-purity maize hybrid seed on yield. Three commercially available types of F_1 single cross maize hybrids known as Anthipi, Aris and Dias were used. Seed mixtures of varying purity were produced by combining different percentages of pure hybrid seed and inbred seed.

The graph below shows the results of different percentages of inbred seed on yield.



[Source adapted from C G Ipsilandis, B N Vafias, A Karagiozopoulou and C K Goulas, *Asian Journal of Plant Sciences*, 2005, 4 (1), pages 75-82]

(a) Define the term *inbreeding*. *[1]*

. . . . . .

. . . . . .

(b) Calculate the difference in yield between the pure hybrid line and the 25 % inbred line for the Anthipi variety. *[1]*

Difference in yield: . . . . . .

(This question continues on the following page)

(Question F1 continued)

(c) Compare the yields for the three hybrids at different percentages of inbreeding. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(d) Predict the percentage of inbreeding that would give a yield of 9000 kg ha^{-1} in the Dias variety of maize. *[1]*

. . . . . .

. . . . . .

F2. (a) State **one** way that plants can reproduce asexually. *[1]*

. . . . . .

(b) Flavr-Savr™ tomatoes ripen but stay firm. Explain how this variety of tomatoes was developed. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

F3. (a) Outline how animal breeding programmes have led to improvements in yields using a **named** example. *[4]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

(b) Explain how manipulation of day length is used in the production of flowers. *[6]*

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

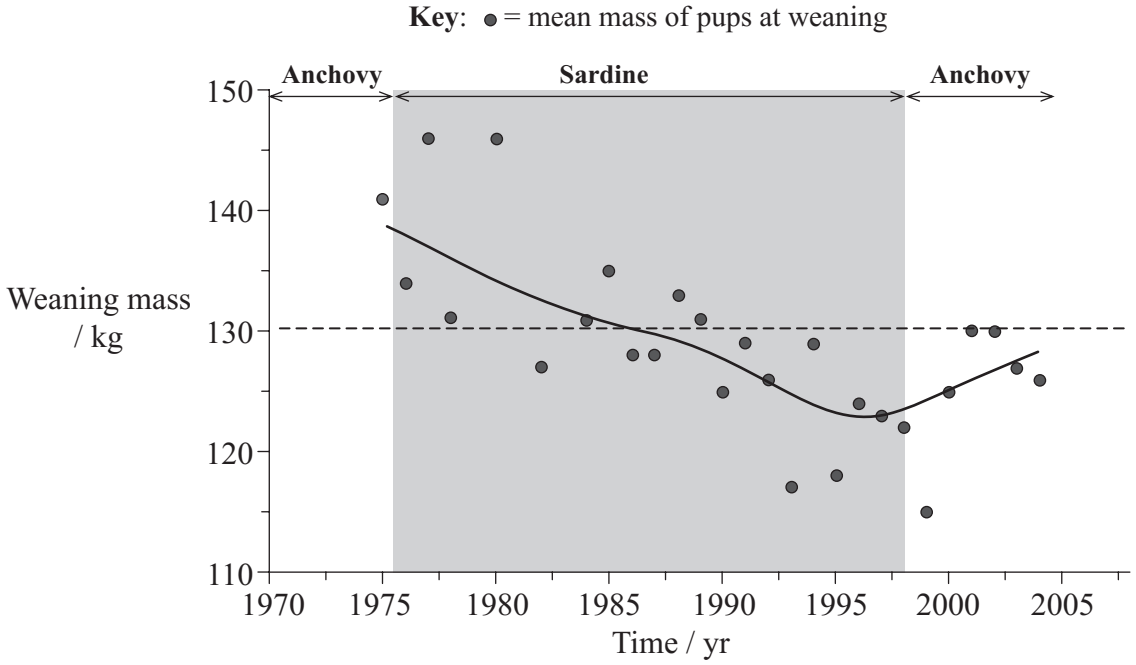
Blank page

Option G — Ecology and Conservation

G1. A long-term study examined the effect of ocean climate on the foraging (hunting) success of northern elephant seals (*Mirounga angustirostris*). Throughout their pregnancy, female northern elephant seals capture fish for food, which is converted to food reserves for milk production. Seal pups feed solely on their mother's milk so a pup's mass correlates positively with the mother's success at foraging.

The Pacific Ocean fluctuates between extended warmer and colder periods. These bring with them changes identified broadly as either an "anchovy regime" (ocean temperatures cooler than normal, increased nutrient supply, high catches of anchovies) or a "sardine regime" (ocean temperatures warmer than normal, overall low productivity, low anchovy but high sardine catch).

The graph below shows the relationship between weaning mass of northern elephant seal pups and anchovy and sardine regimes.



[Source adapted from: B J Le Bœuf and D E Crocker, *BMC Biology*, (2005), **3**, page 9]

(a) Calculate the greatest difference in weaning masses during the sardine regime. *[1]*

Greatest difference : . . . . . .

(This question continues on the following page)

(Question G1 continued)

(b) Describe the relationship between mean weaning mass and the sardine and anchovy regimes from 1975 to 2004. *[1]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) Discuss what type of ocean water temperatures result in more successful foraging by female northern elephant seals. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

G2. (a) Explain how chemoautotrophs obtain energy to synthesize ATP. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) Outline the chemical effects of chlorine on the ozone layer. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

G3. (a) Describe ecological succession using a **named** example. *[5]*

(b) Discuss the advantages of *in situ* conservation of endangered species. *[5]*

Blank page

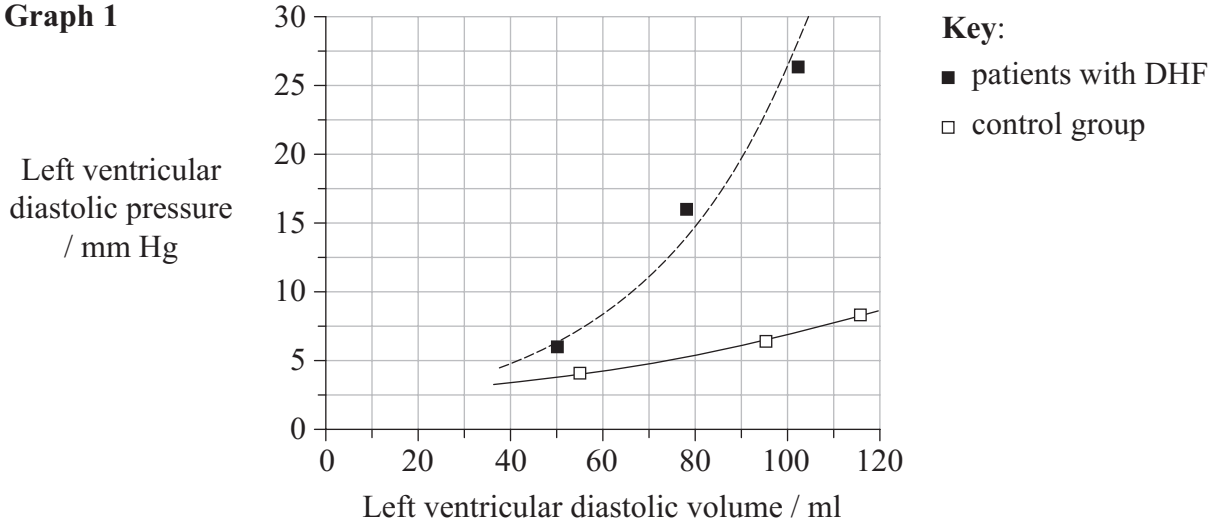
Option H — Further Human Physiology

H1. One type of heart disease is diastolic heart failure (DHF). A study was carried out to see if DHF was related to abnormalities in the diastolic properties of the left ventricle. Two groups of patients, one with DHF and the other the control group with no symptoms of DHF, were assessed to compare:

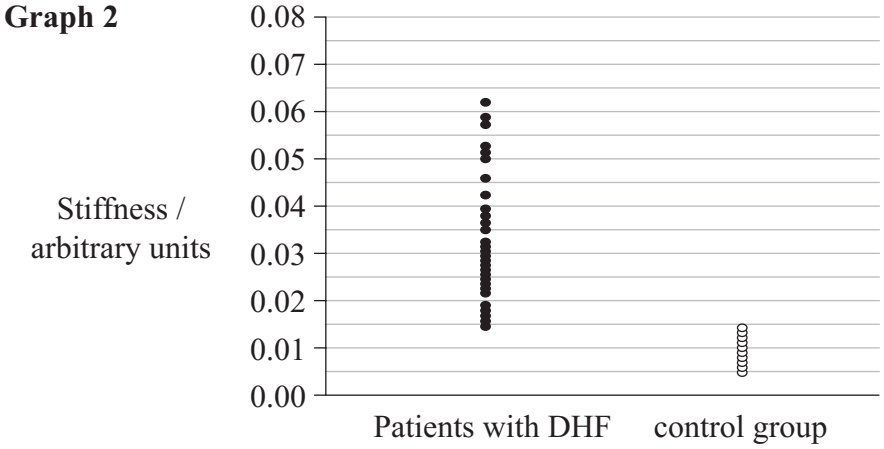
- changes in left ventricular diastolic pressure and volume
- and stiffness of muscles leading to resistance of the left ventricle to stretch under increasing pressure.

Graph 1 shows the mean lowest pressure in the left ventricle during diastole after the opening of the atrio-ventricular valve. Graph 2 shows individual stiffness constants.

Graph 1



Graph 2



[Source adapted from: New England Journal of Medicine, Vol. 350, Number 19, May 6, 2004, "Diastolic Heart Failure — Abnormalities in Active Relaxation and Passive Stiffness of the Left Ventricle", M R Zile, C F Baicu, and W H Gaasch, pp. 1953-1959, Fig. 2 and 3.

(This question continues on the following page)

(Question H1 continued)

(a) Identify the left ventricular diastolic volumes in patients and the control group that correspond to a pressure of 5 mm Hg. *[1]*

Patients: . . . . . .

Control group: . . . . . .

(b) Compare the diastolic pressure-volume relationship of patients with DHF and the control group. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) Distinguish between the stiffness constants in the two groups of patients. *[1]*

. . . . . .

. . . . . .

. . . . . .

(d) (i) Suggest why in patients with DHF there is little or no increase in blood volume pumped out of the left ventricle with each contraction during exercise. *[1]*

. . . . . .

. . . . . .

. . . . . .

(ii) Deduce how patients with DHF would respond to heavy exercise. *[1]*

. . . . . .

. . . . . .

H2. (a) State **two** components of bile. *[1]*

. . . . . .

. . . . . .

(b) Outline the process of erythrocyte breakdown in the liver. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

H3. (a) Explain the control of ADH secretion. *[5]*

(b) Explain how structural features of an epithelium cell in a villus are related to its function. *[5]*